Beam shape at DØ

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Beam width measurement at DØ

The model we are using is very simple:

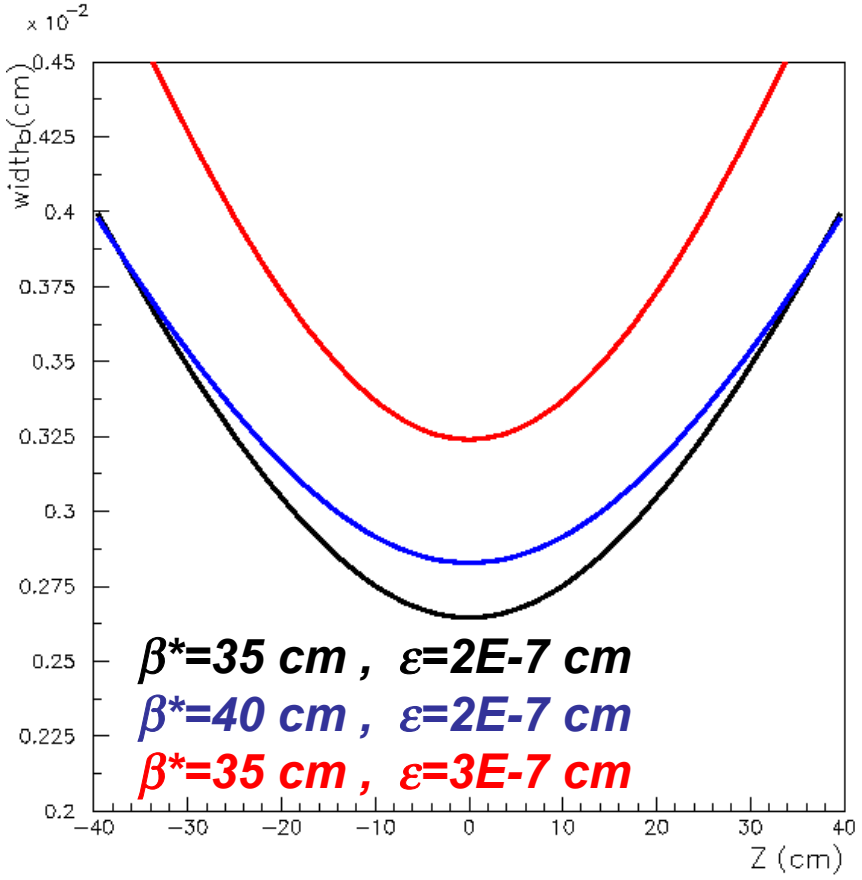
Two beams with no X-Y coupling, same “optic” for p and pbar.

The interaction region is a drift in the Tevatron, one expects.

$$\sigma^2 = \varepsilon_{eff}\left[\beta^* + \frac{(z - z_0)^2}{\beta^*}\right]$$

$$\varepsilon_{eff} = \frac{\varepsilon_p \varepsilon_{pbar}}{\varepsilon_p + \varepsilon_{pbar}}$$

In the beams division they expect ***β*=35 cm.***



measurement of the shape of the luminous region

vertex method

$$\sigma^2_{obs} = \sigma^2_{beam} + k \times \sigma^2_{vertex}$$

Uses:

•coordinates of the reconstructed vertexes

•estimated errors on this vertexes

Assumes:

•unbiased reconstructed vertex position

•error estimation proportional to the real error

pair of tracks method

$$d_i = y\cos(\varphi_i) - x\sin(\varphi_i)$$

$$\langle d_1 d_2 \rangle = \sigma^2_F \cos(\varphi_1 - \varphi_2)$$

Uses:

•track parameters

Assumes:

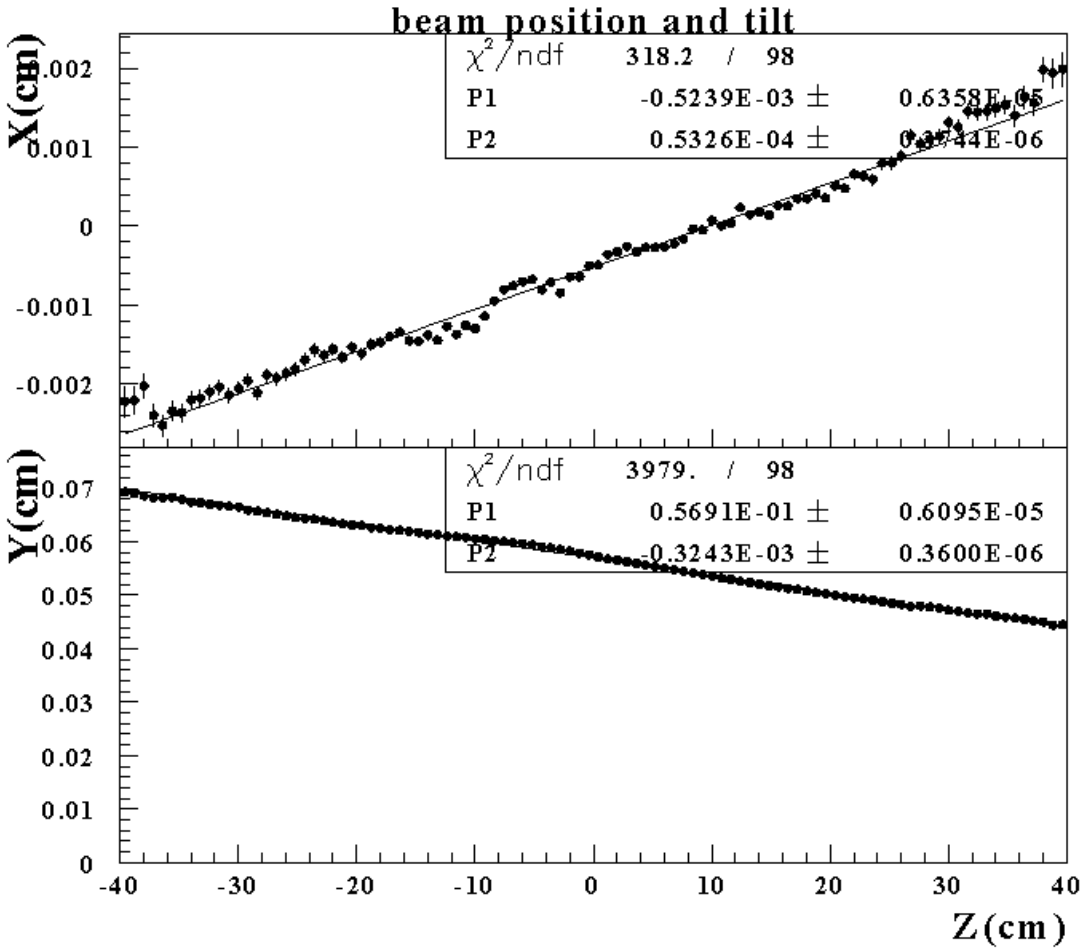
•unbiased track parameters

•uncorrelated errors in the track parameters

Here I assume circular beam, but in our calculation we do not make this assumption (formula a bit more complicated).

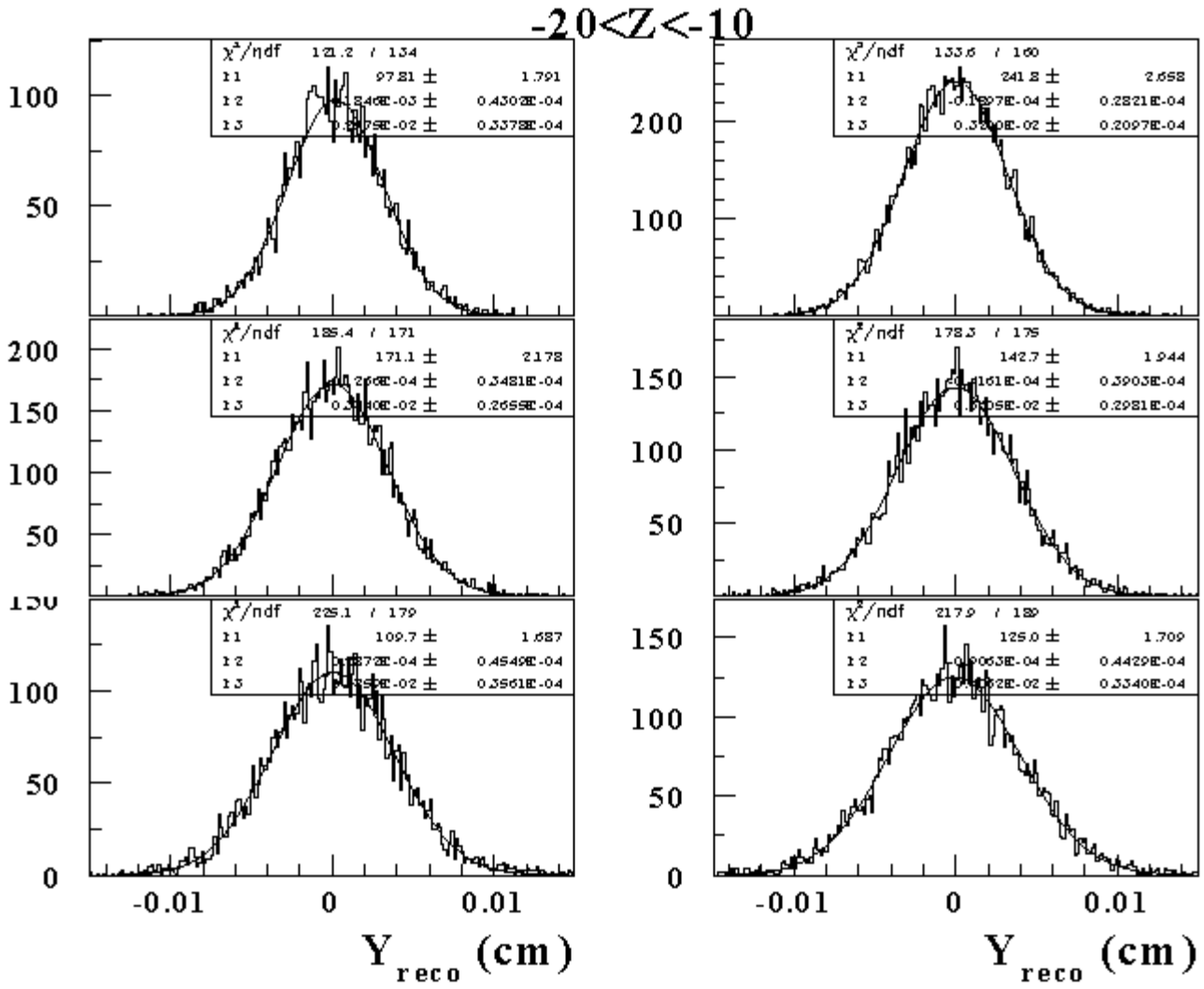
Vertex method. Step 1

Take one full run, and determine the beam tilt and position for X and Y independently.

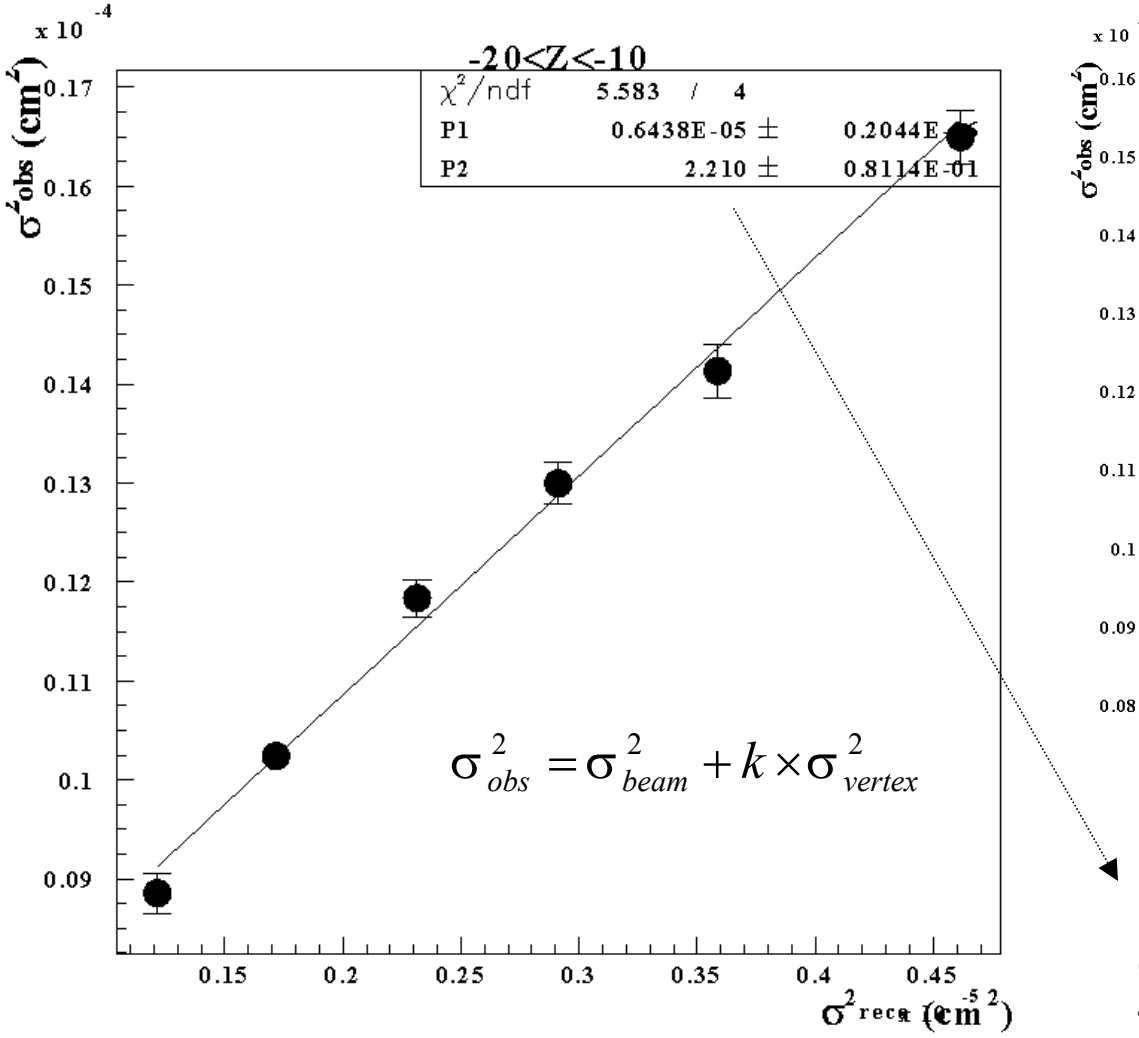


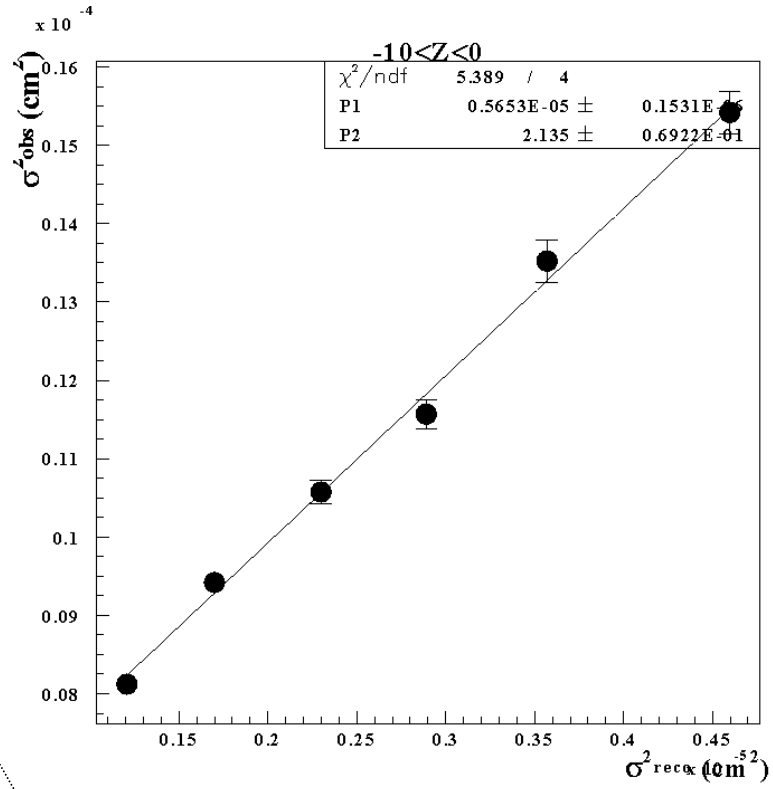
Vertex method. Step 2

For each Z beam (10 cm), separate the data in σ_{reco} bins and fit the width of the observed discribution.



Vertex method. Step 3

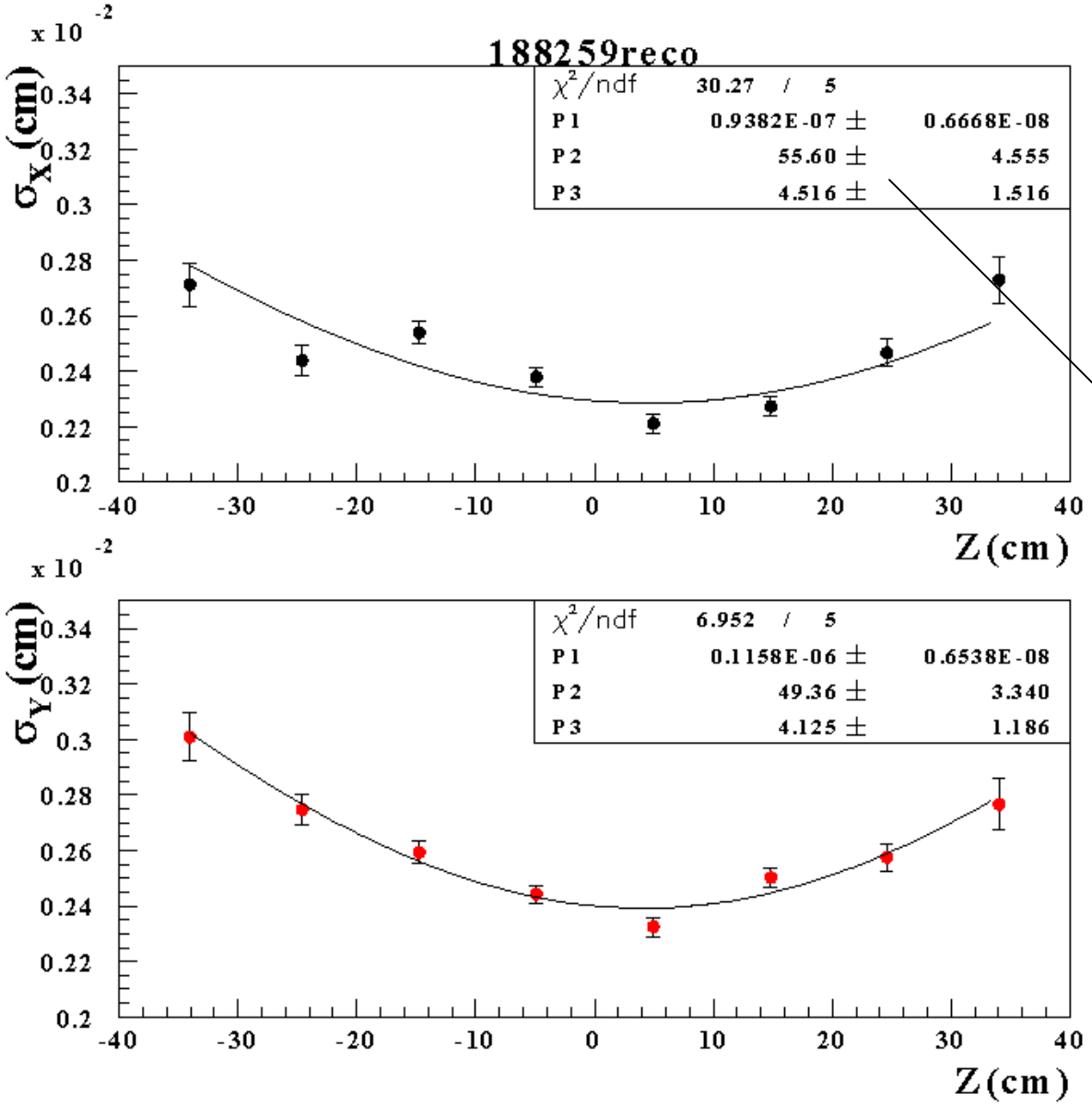




k=1 if you have a good estimator for the error in the vertex position.

fit the linear equations and determine k and σ_{beam}.

Vertex method. Step 4

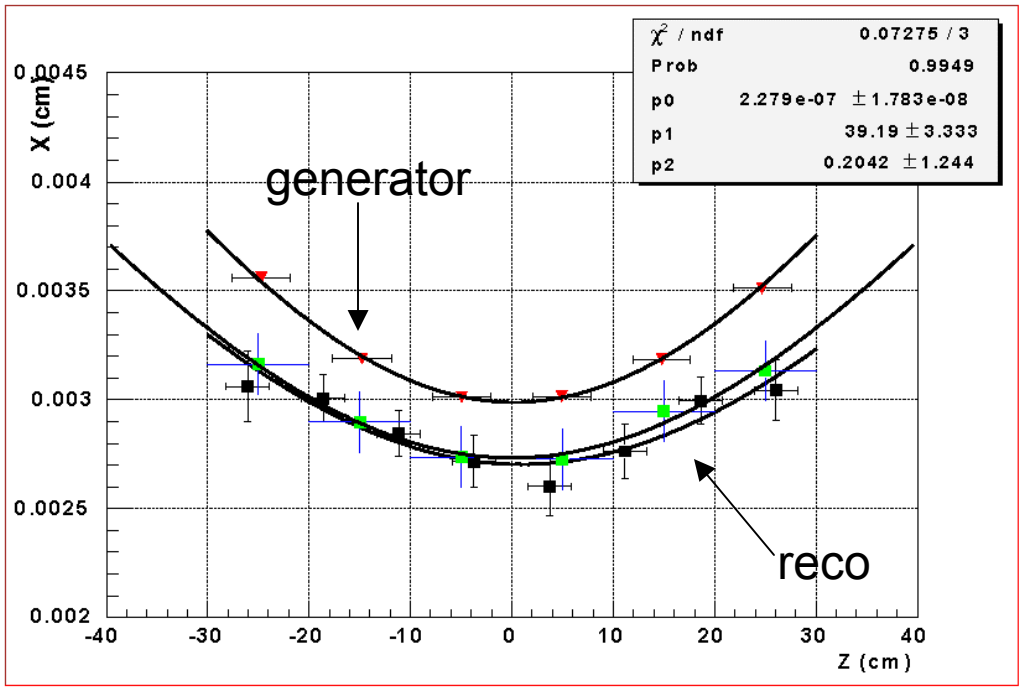


Fit β*

$$\sigma^2 = \varepsilon_{eff}\left[\beta^* + \frac{(z - z_0)^2}{\beta^*}\right]$$

Tevatron department will say this β* is impossible.

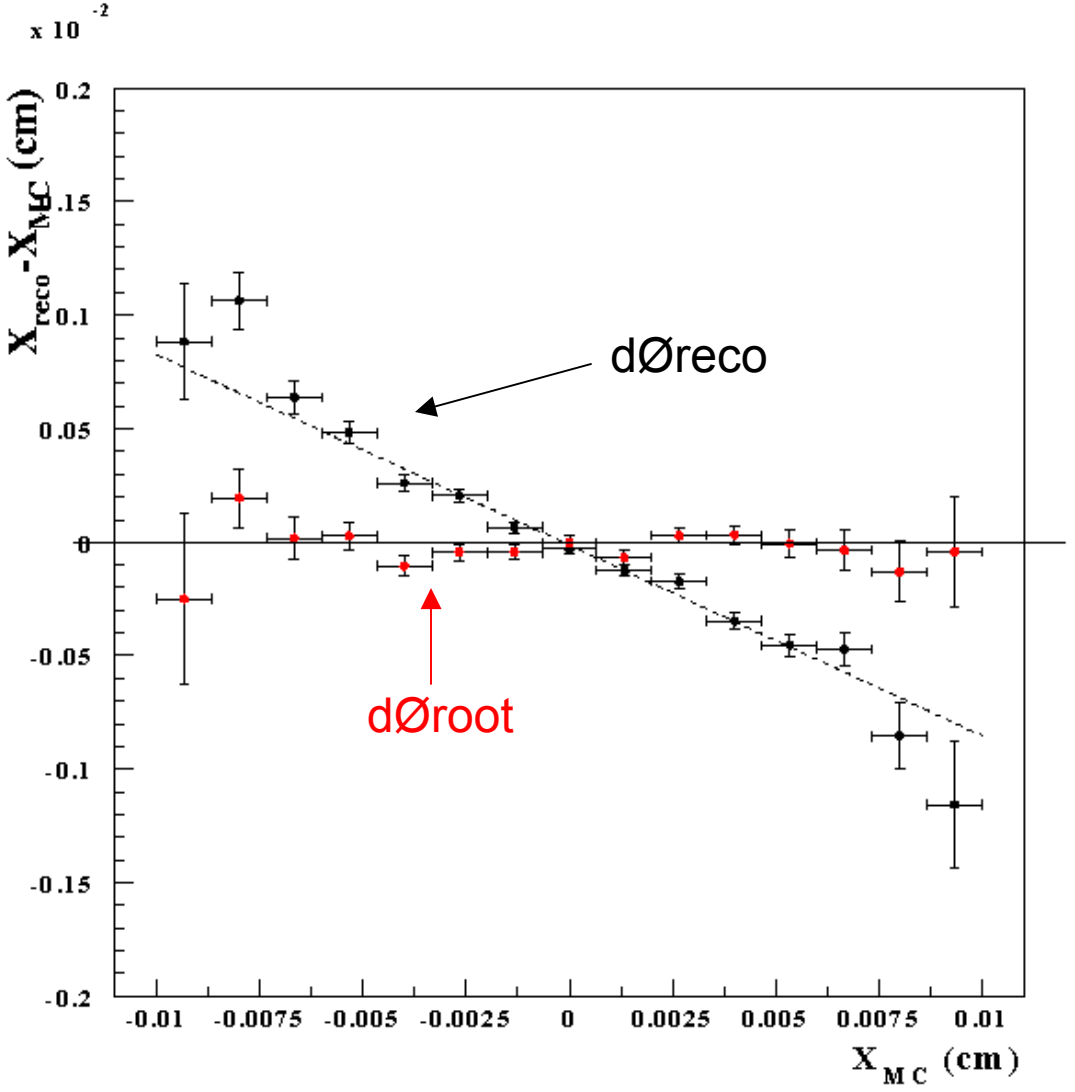
Calibration using MC



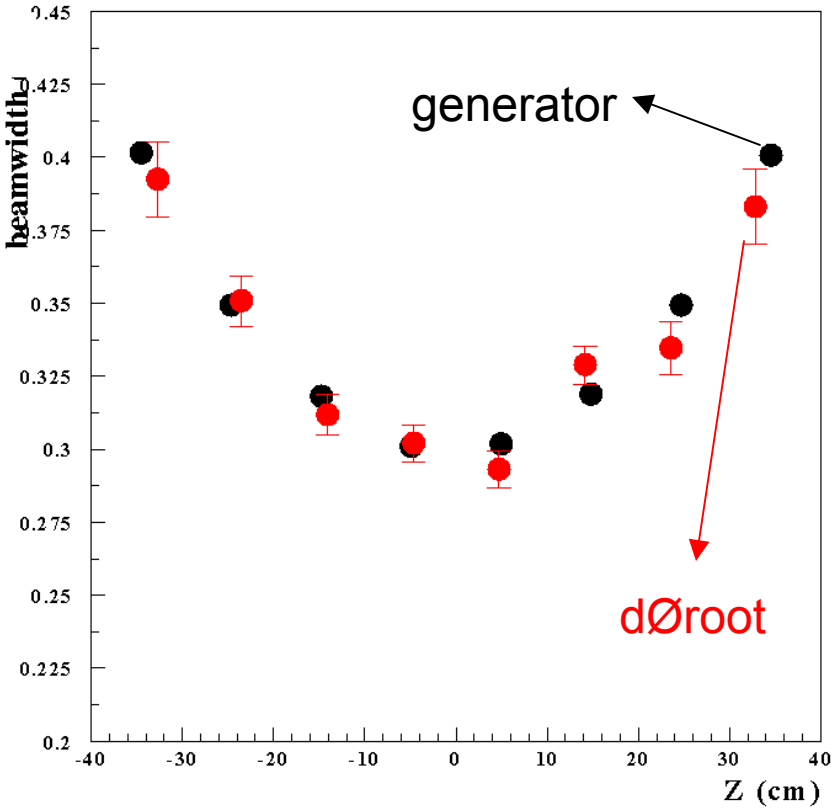
Using reco both method give us a 10% bias. For the vertex method this is solved with the re-vertexing done in dØroot.

Calibration using MC

The bias we were seeing in the vertex reconstruction goes away when the vertex from dØroot is used.

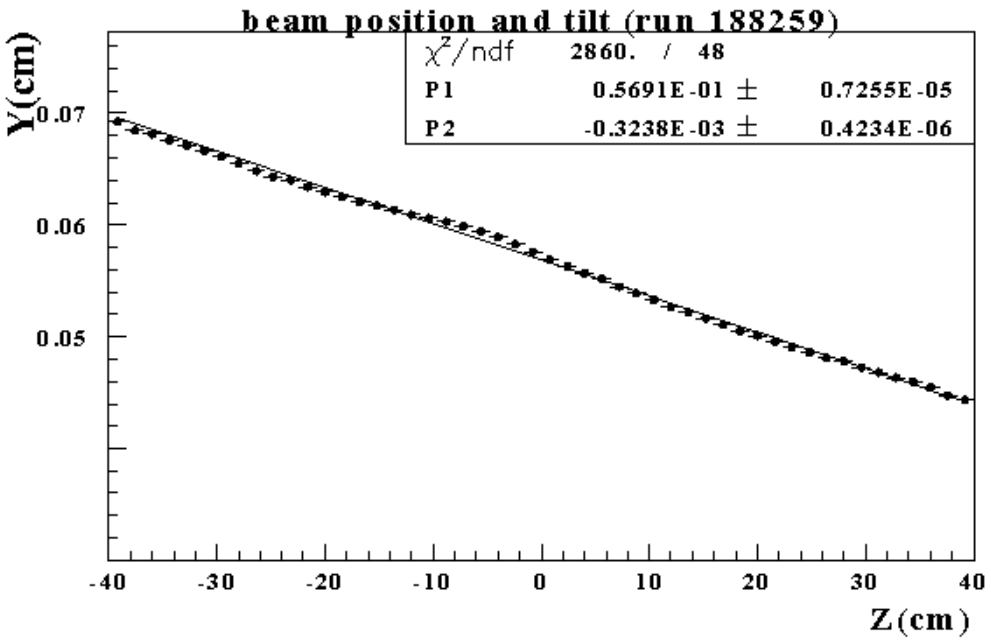


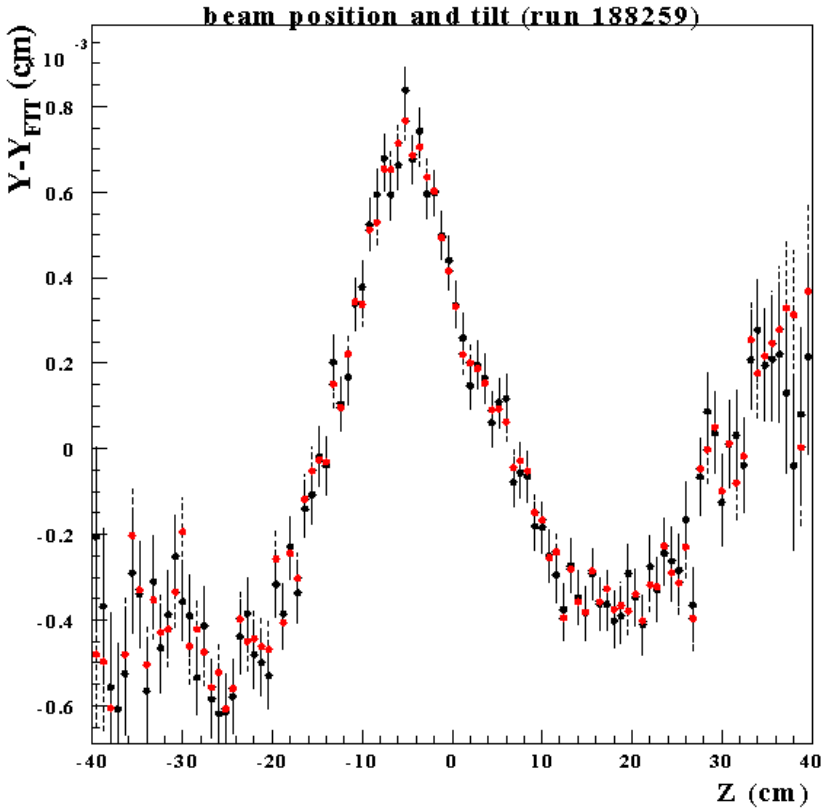
MC calibration



Using dØroot the bias goes away (in the vertex method). We can get the right shape from MC when we use dØroot.

Beam position

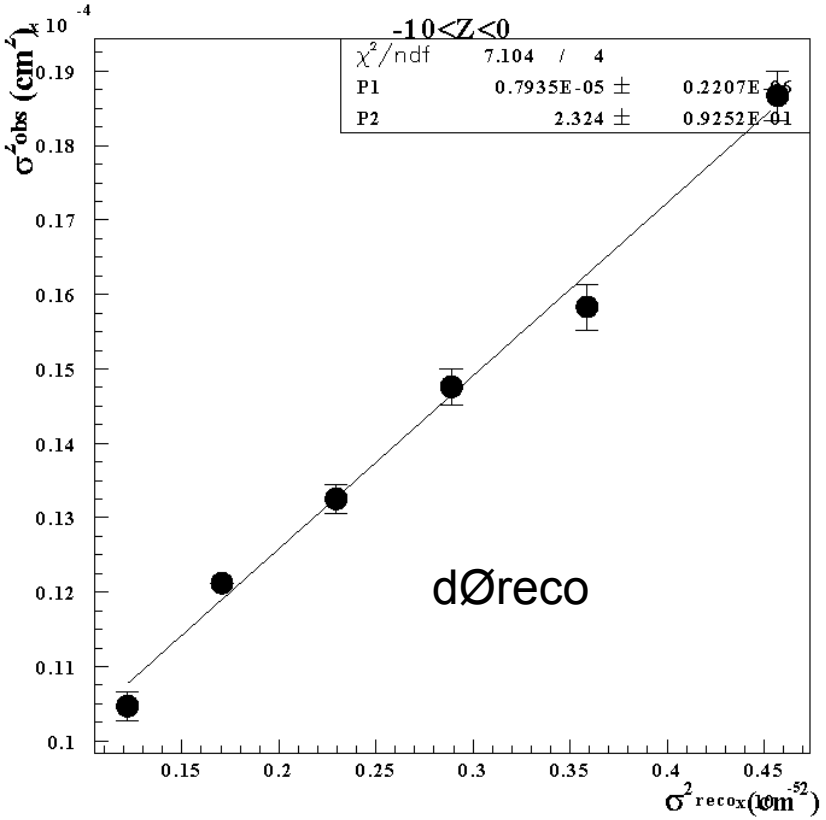


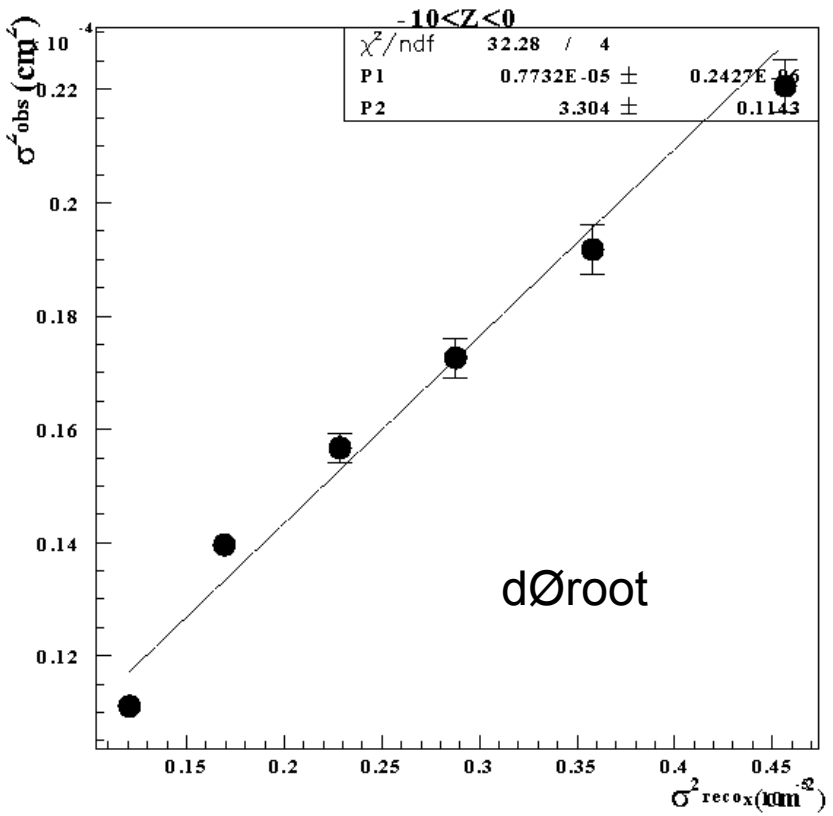


We can see the beam “turning” inside our detector.

Do you expect this? misalignment?

Error slope (k)

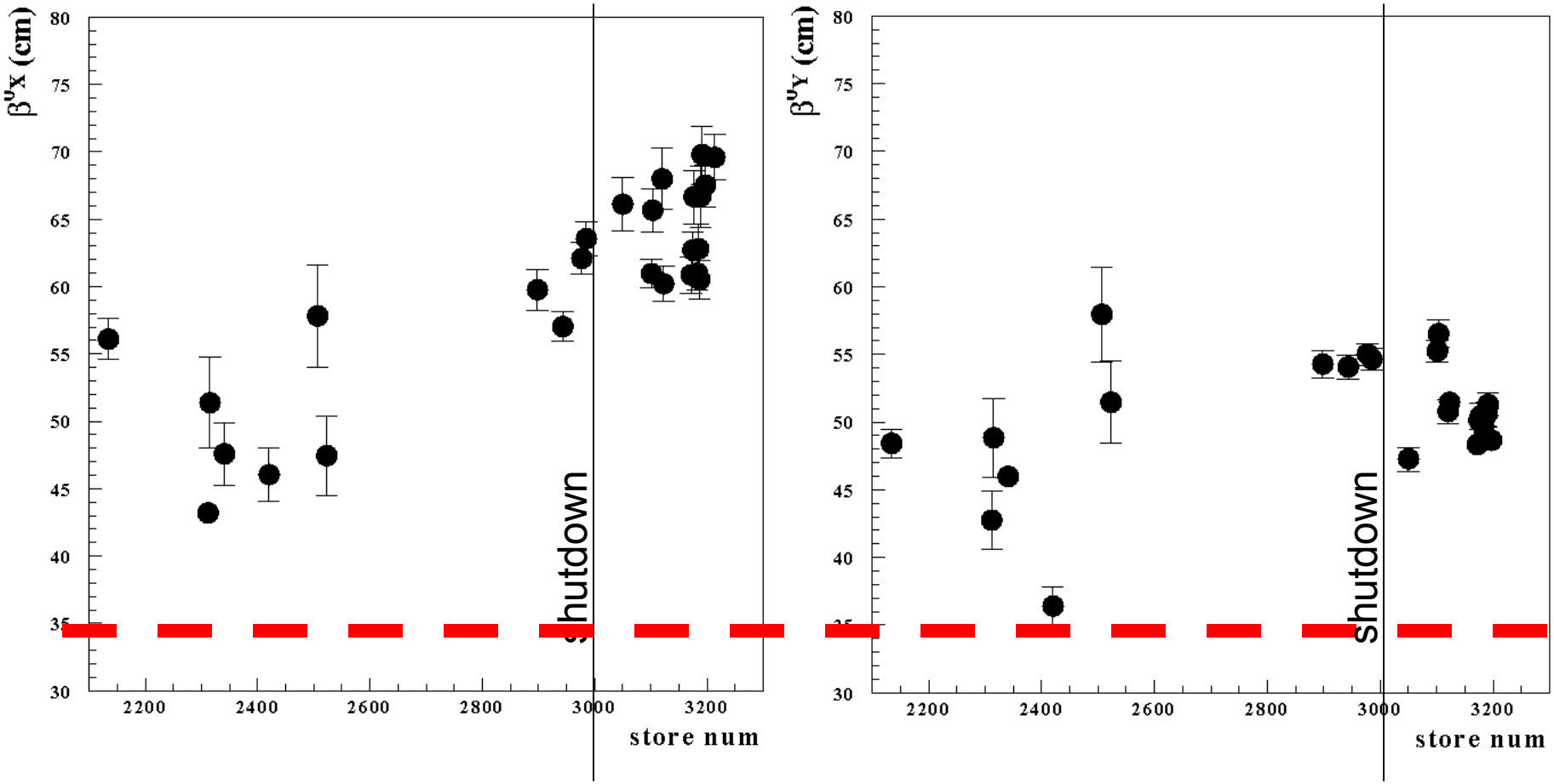




dØroot has larger k than dØreco.

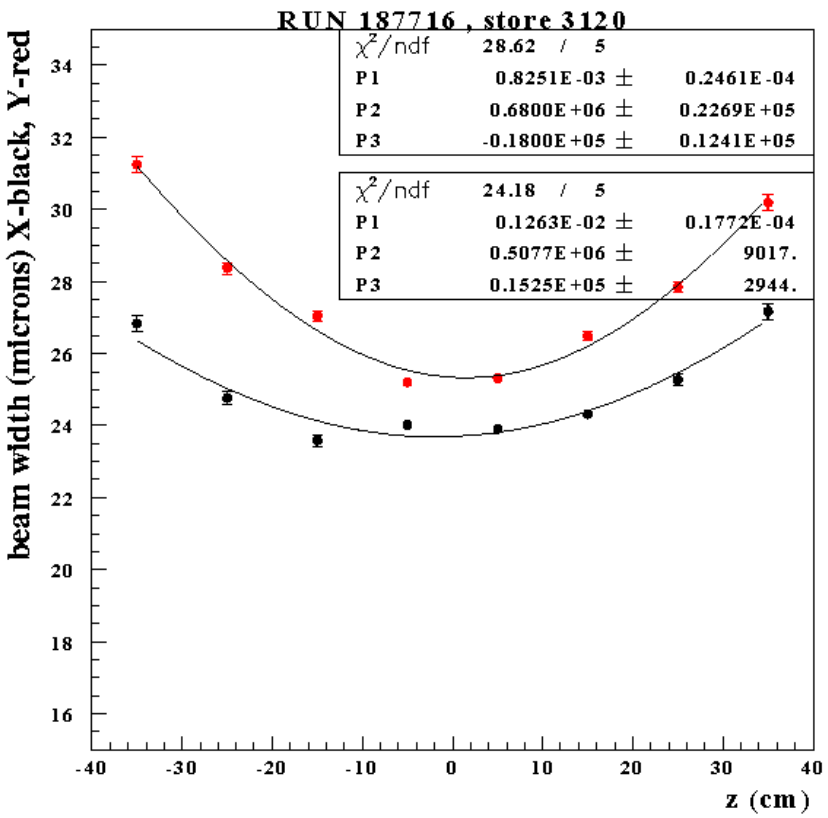
β^* measurement

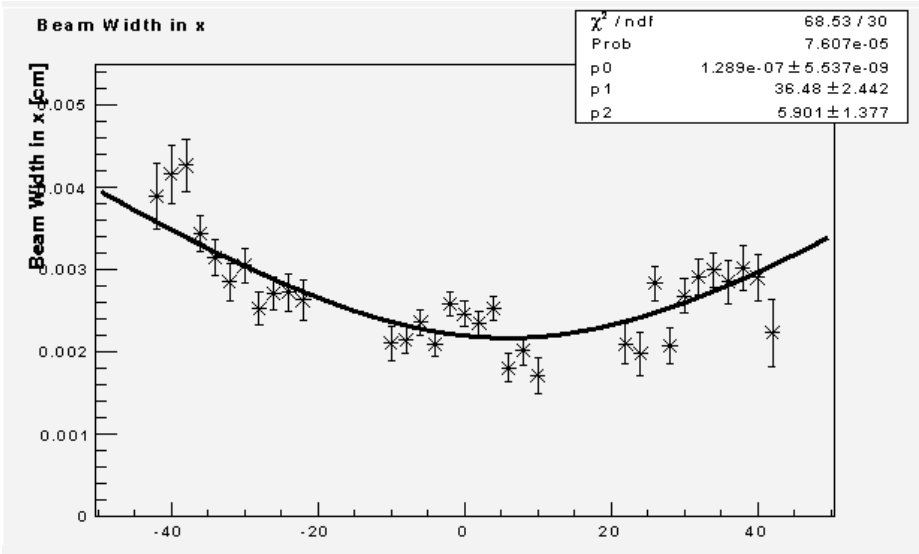
Now we are starting to calculate the beam shape in a regular basis, and the information is communicated to the Tevatron department (Vaia Papadimitriou), working in this project with Avdhesh Chandra, student from Tata Institute.

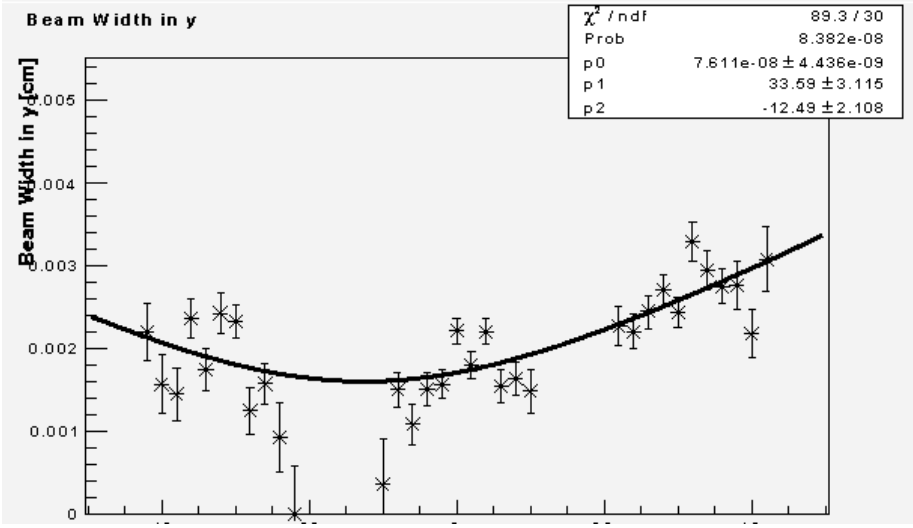


This information is online and Tevatron department has access to it.

DØ vs BØ comparison







Forget about the fit, look at the shapes….

Conclusion

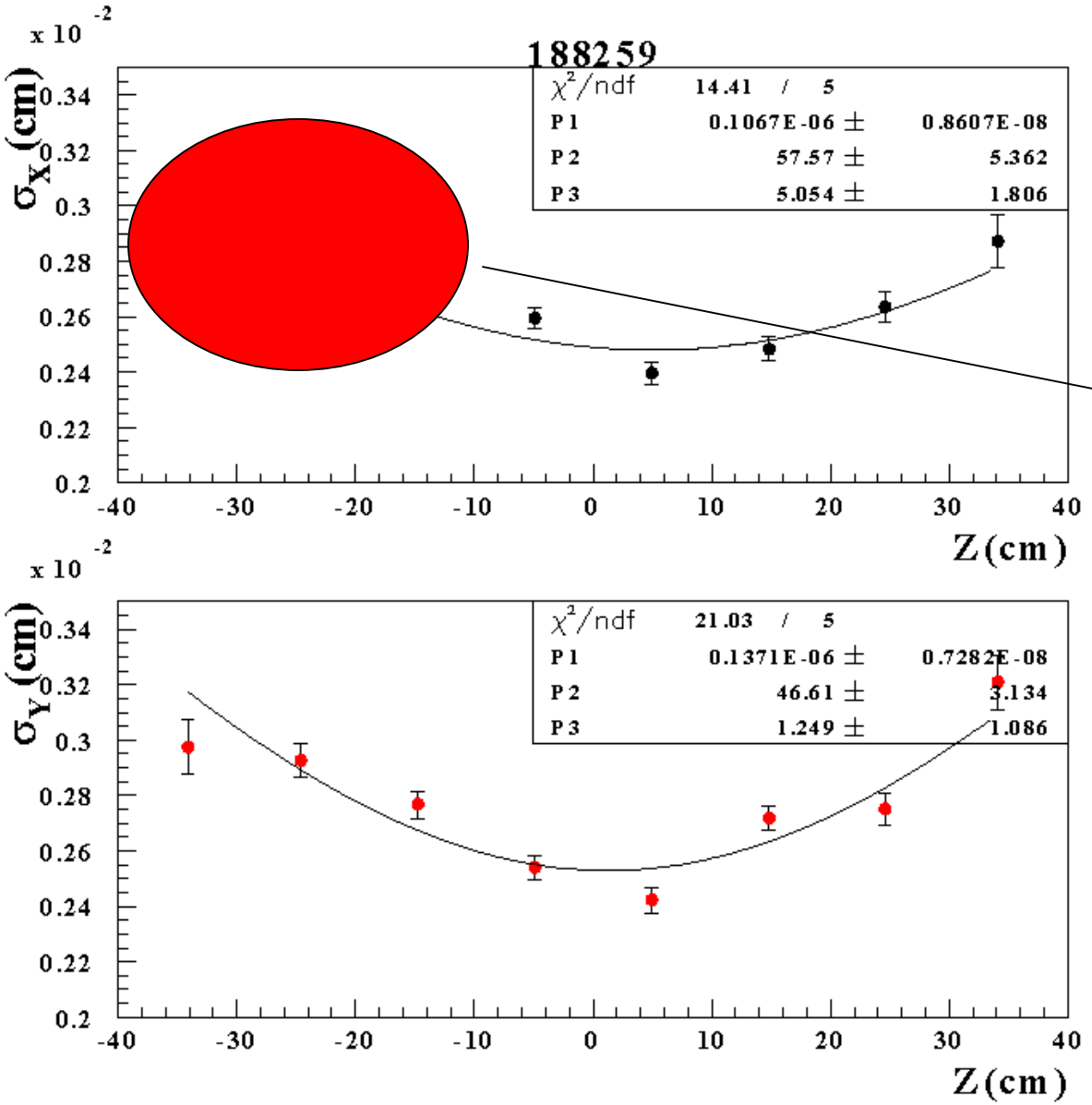
The last time we presented the beam analysis to the tracking group we showed a 10% bias in the reconstructed vertex compared to the generator level vertex. Thanks to the people in this group that helped with this (Sara and Ariel). dØroot solves this problem, but is painful to run it in large samples. Is there a plan to include the new vertexing as part ofd0reco?

The track method still has a bias, I think this is pointing to a bias in the dca of the tracks. Did someone in this group study a possible bias in the dca of tracks?

Is there anyone else looking at this beam slopes?

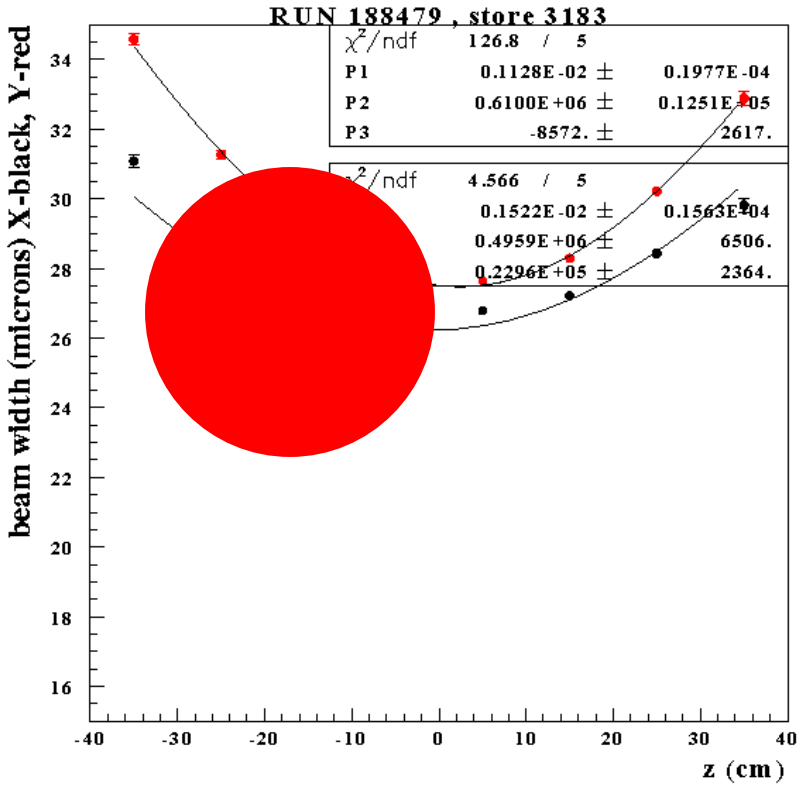
In my opinion this measurement is very important to understand the quality of the IP at DØ.

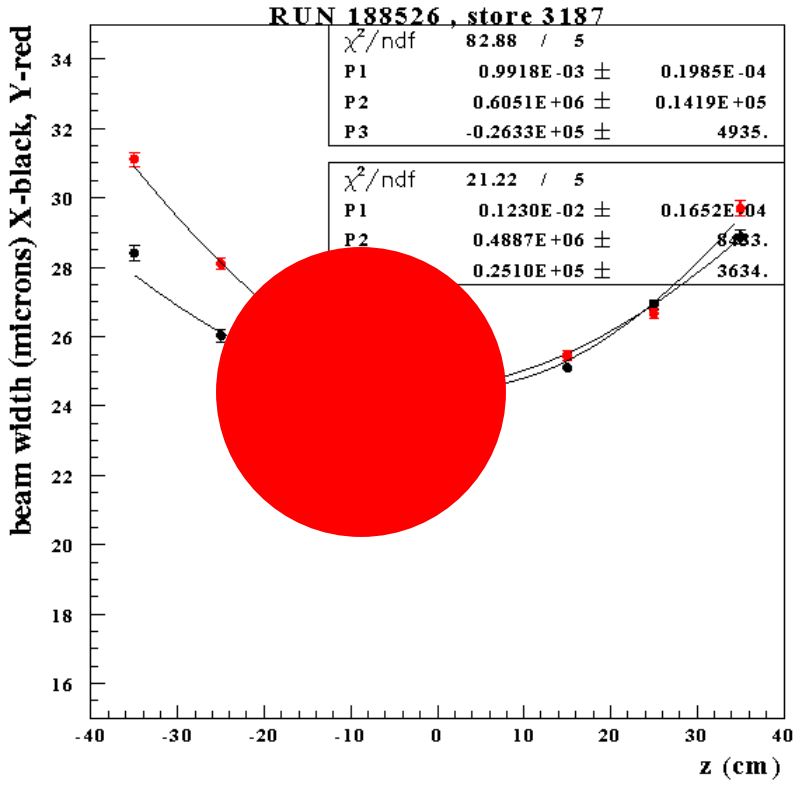
Vertex Method. Step 4 (again)



It looks like this after the shutdown.

More stores…





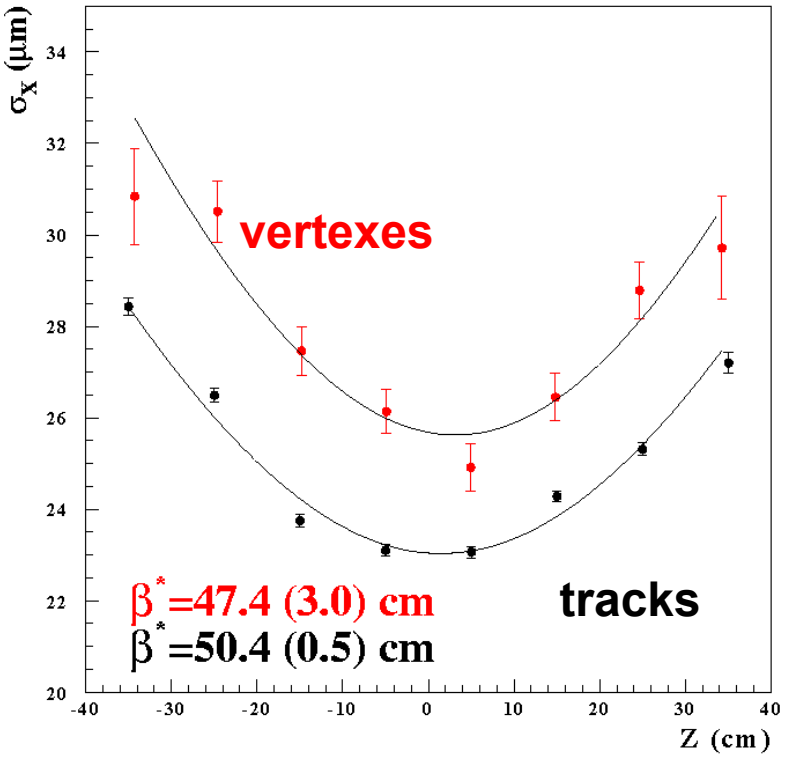
The trend is always there….

β^0 measurement: systematics

Evaluation of the systematics comparing our two measurements.

We still have systematic uncertainty in beta*. **The two different measurements still give different result** . This translates into 5% uncertainty in the luminosity ($\propto 1/\beta^*$) calculation using the beam instrumentation measurements. **Work going on to reduce this uncertainty**.

This uncertainty can not explain the difference between 35 and 50 cm.

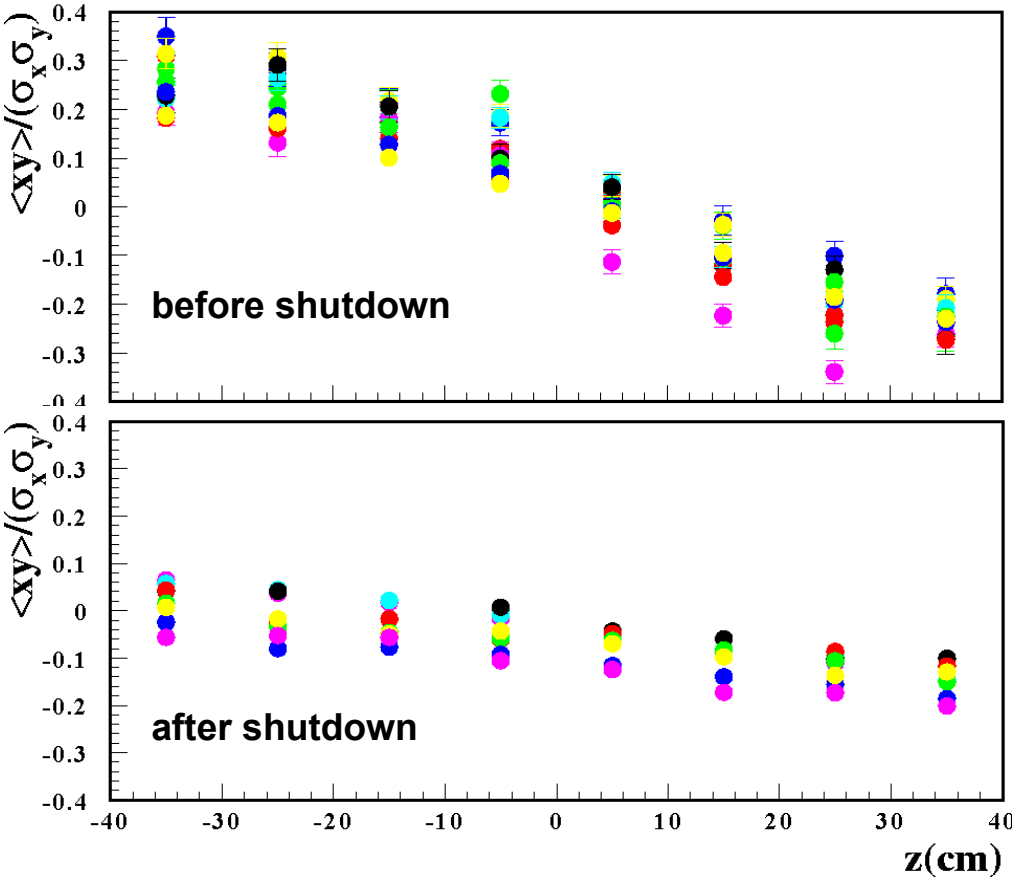


X-Y coupling

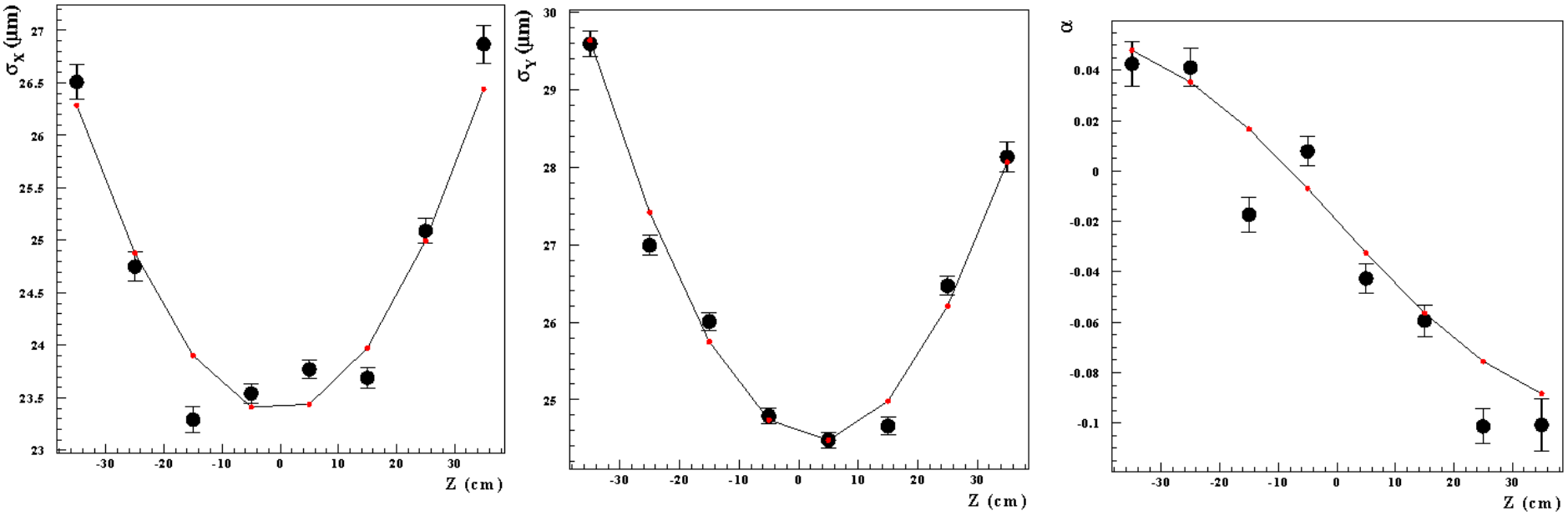
Our model for the β^* measurements is too simple, start taking into account other things. For example, couplings:

After the shutdown the X-Y coupling at DØ has been significantly reduced.

consistent with the expectations from the Tevatron department (Valeri Lebedev)



X-Y coupling (model from V.Lebedev)



This model still does not take into account p-pbar differences. More complex picture (10 beam parameters instead of 3).

Still gives β^*~60 cm for X and β^*~50 cm for Y. Does not solve the problem!